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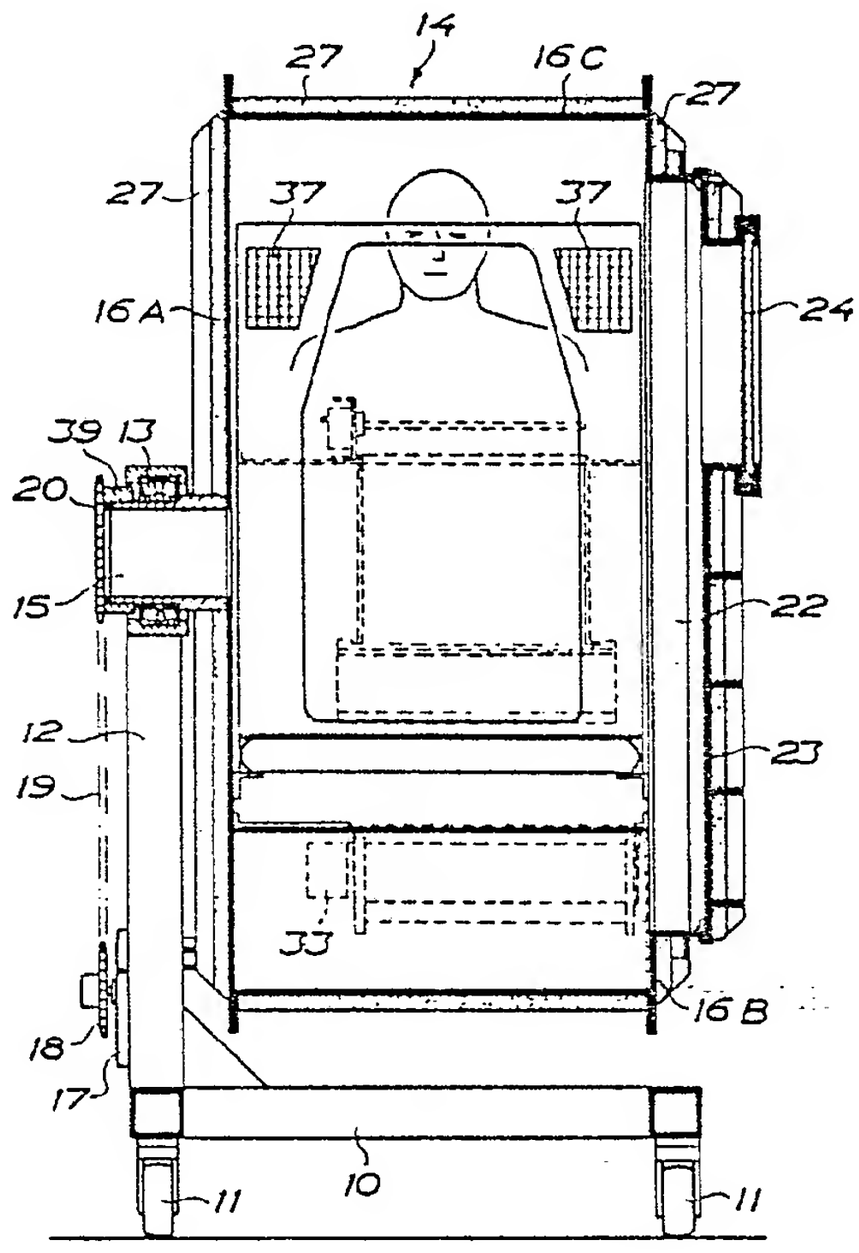
(54) Title: APPARATUS FOR EXAMINATION AND/OR TREATMENT OF A PERSON

(57) Abstract

Apparatus for examination and/or treatment of a person. The apparatus comprises a pressure-tightly closable container (14) with a resting-surface (28, 29) therein for supporting a person included in the container. The container is pivotally mounted for rotation about a substantially horizontal axis. An external unit (40, 41, 42) is connected to the container for inducing an overpressure or underpressure therein. Means are provided for supplying pressure, flow or other signals from the container and from the respiratory ways of the middle ear of the person included in the container. By rotating the container the person enclosed therein can be examined at different elevations.



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Apparatus for Examination and/or treatment of a person

This invention relates to an apparatus for examination and/or treatment of a person by methods which require indication and/or induction of pressure variations or air flow in the respiratory ways or the middle ear and/or variations of the ambient pressure.

Chambers that can be pressure-tightly closed have already been used in body plethysmography, the mechanics of the respiration being studied e.g. in order to determine the respiration flow rate, the lung pressure, etc. In that case the investigation has always been made with the subject sitting in erect position, which involves a considerable limitation of the investigation because it is not possible e.g. to determine if existing stenoses consist of functional mucosal stenoses or of organic stenoses.

Previously, pressure chambers have also been used for investigation of the pressure equilibrating capacity of the Eustachian tube via the volume position of the tympanic membrane, the subject as well as the investigator and the devices used in the investigation for measurements and indications being enclosed in the pressure chamber which therefore must have a large volume. Such pressure chambers have also been used when treating basal sensorineural hearing loss in connection with Mb Meniere's disease.

The object of the invention is to provide an apparatus of the kind initially referred to, which allows that the subject is examined sitting or lying at different elevations and also that the chamber pressure is adjusted to a desired overpressure or underpressure in relation to the atmospheric pressure or is being varied periodically, in order to provide a facility for examination and treatment, which can be used universally and thus can be used not only in such connections as those mentioned above but also in other connections

where prior art pressure chambers could not be used.

According to the invention, an apparatus of the kind referred to is characterized by the combination of a pressure-tightly closable container, an external unit for inducing an overpressure or underpressure in the container, a resting-surface for supporting the person enclosed in the container in an erect or recumbent position, a frame pivotally mounting the container for rotation about a substantially horizontal axis allowing the person enclosed in the container to be positioned at different elevations on the resting--surface, means for supplying pressure, flow or other signals from the container, and means for supplying pressure, flow or other signals from the respiratory ways or the middle ear of the person enclosed in the container.

The invention provides the possibility to distinguish between functional mucosal stenoses and organic stenoses in the respiratory ways by measuring the respiration resistance in different body positions. It is known that the blood-filling of the mucosae within the respiratory ways and the Eustachian tube changes with the body position. A functional mucosal stenosis occurs only when the patient is in the recumbent position and is caused by the increased blood-filling, which causes an increase of the respiration resistance, while organic stenoses cause an increased respiration resistance already with the patient in the erect position. By the apparatus according to the invention it is thus possible to apply a simple, rapid and painless method of analysing the respiratory obstacles of a patient and to decide rapidly by guidance of the data obtained if the stenosis can be treated medically or if surgical operation should be performed. The possibility of varying the elevation during the investigation is an

important factor also when analysing different illnesses because many diseases are demonstrated by symptoms when the patient is in the recumbent position, such as acute otitis, croup of children, etc. The influence of the positional changes on the mucosae can be analysed, and suitable vascular medicines which counteract such swelling of the mucosae as is depending on the position can be objectively tried out.

By measuring the changes of the elastic properties of the tympanic membrane at pressure changes in the container of the apparatus according to the invention it is possible to quantitatively follow the pressure equilibrating capacity of the Eustachian tube at different body elevations. This measuring method will be used above all for selecting persons having a good pressure equilibrating capacity at different elevations, which are suitable for advanced diving or aviation. During diving the descent takes place at an elevation at which the body is directed more or less downwards, the equilibrating ability being considerably impaired thereby. The same phenomenon occurs at advanced aviation. By selecting at an early stage candidates which have a good equilibrating capacity at different elevations one can make the choice before an expensive education is initiated; it may otherwise be necessary to interrupt such education due to the fact that the subject has symptoms of severe ear pains or vertigo. Moreover, by this selective method it is possible to exclude many divers and airmen having a limited pressure equilibration reserve, i.e. such individuals as are incapable of diving or flying for extended periods due to the slightest cold.

The apparatus according to the invention also makes possible investigation under infrasonic exposure. By the connection of a piston pump the volume of which is

variable according to a sinuous frequency, to the interior of the container it is possible to vary the infrasonic level in the container as desired and to indicate simultaneously the eye movements controlled by the balance organ of the ear. It is known that the balance sensitivity of the ear to slow pressure changes varies with the body elevation, and thus it is possible to investigate by means of the apparatus according to the invention the individual sensitivity to infrasonic exposure at different elevations.

Finally, it is possible to perform by means of the apparatus according to the invention hearing-improving pressure treatment e.g. in connection with Mb Meniere's disease. This ear disease which is relatively common disables many persons and causes attacks of vertigo and impaired hearing (deafness). Tests that have been made indicate that it is possible to interrupt an acute Mb Meniere attack, and probably the fact is that the sooner such attacks can be interrupted at an early stage, the less is the risk of progress and thus the appearance of permanent damage of the hearing and balance organs. In the container of the apparatus according to the invention hearing and vertigo can be measured simultaneously at underpressure exposure for controlled interruption of the acute attack. In most cases the patient has such a severe disabling vertigo that he cannot be sitting in erect position at the pressure treatment, rotation of the patient towards recumbent horizontal position during the test being necessary, which can be made when the apparatus according to the invention is being used.

In addition to this, the apparatus according to the invention can be used in the conventional manner as a plain body plethysmograph for studying the mechanics of respiration.

In order to illustrate the invention this will be described in more detail with reference to the accompanying drawings in which

FIG. 1 is a cross-sectional view of the apparatus according to the invention taken transversely of the container axis;

FIG. 2 is a cross-sectional view of the apparatus taken along the container axis; and

FIGS. 3 to 7 are diagrams illustrating different investigations which can be performed by using the apparatus according to the invention.

The apparatus disclosed in FIGS. 1 and 2 comprises a chassis 10 on swivelling castors 11. A bearing bracket 12 projects from the chassis at one side thereof and is provided with a heavy roller bearing 13. A cylindrical container 14 is pivotally mounted to one side of the bearing bracket 12 in the roller bearing 13 by means of a central tubular trunnion 15 on one end wall 16A of the container overhanging the chassis, so that the container can be rotated about the horizontal central axis thereof. An electric motor 17 is supported by the bearing bracket and is operatively connected by means of a chain wheel 18 and a chain 19 to a chain wheel 20 on the trunnion for rotating the container. Supplementary support rollers 21 can be provided on the bearing bracket 12 and run on the end wall 16A.

In the other end wall 16B of the container there is provided an opening 22 through which the chamber formed by the container is available, and this opening is pressure-tightly closable by means of a door 23 of the autoclave type, provided with a window 24. A window 25 is provided also in the cylindrical wall 16C of the container. One or more tubular studs 26 for connecting conduits to external units controlling the air pressure in the chamber or measuring changes of the gas volume or

the pressure in the chamber are provided in the end wall 16A. All walls of the container including the door are provided with an external sound insulation 27.

In the chamber 14 there is provided a seat 28 preferably with a safety belt including shoulder straps (aeroplane safety harness), and a seat back 29. The seat back is mounted on one side of a vertical partition wall 30 which joins a fan housing 31 located below the seat. A fan 32 is mounted in the fan housing and is connected to an electric drive motor 33 for circulating air in the chamber, this air being drawn into the chamber through an air intake 34 below the seat and being conveyed through the passage defined by the fan housing and the partition wall, through a cooling-coil battery 35 and a heating element 36 to be discharged through openings 37 provided with grids, at each side of the seat back at the upper end thereof as is indicated by arrows. The cooling-coil battery is connected to a refrigerating machine 38 supported by the chassis. Thus, it is possible to control under any condition the temperature in the chamber and to maintain the temperature at an acceptable and substantially constant level, preferably by thermostatic control, when the apparatus is being used. The heat radiation from the subject being examined and from lighting provided in the chamber tends to raise the temperature in the chamber, and therefore the cooling-coil battery most frequently has to maintain the temperature at proper level.

In the chamber measuring means of different kinds can be located as will be described below, and conduits from such measuring means as well as electric conduits for the heating element, the fan and other electrical equipment, such as lighting, communication system, etc,

and conduits between the cooling-coil battery and the refrigerating machine can be extended through the tubular trunnion 15 and pass tightly through a cover 39 mounted by screws on the trunnion, to equipment outside the chamber. Alternatively, a separate lead--through can be provided for these conduits at any place on the end wall 16A.

The drive motor 17 of the chamber preferably is combined with an electric disc brake which is normally engaged when the drive motor is de-energized and is inoperative, but will be disengaged when the drive motor is energized. When the drive motor is de-energized the brake will thus be engaged so that the rotation of the chamber suddenly will be interrupted. Preferably, the angle of rotation is limited to 120° clockwise as seen in FIG. 1 from the normal or zero position shown, and such limitation can be provided by using limit switches. An indicator can be provided externally of the chamber for indicating the actual rotational position.

As indicated in the drawings, a person can be sitting on the seat and by rotation of the container the person can be inclined more or less backwards from the erect (vertical) position to a recumbent horizontal position on the seat back. Then further inclination backwards in the recumbent position can take place within the indicated range of movement of 120°. At extreme elevations the person is retained on the seat by means of the safety belt.

In order to produce a desired pressure in the chamber, either an overpressure or an underpressure, a separate mobile pressure equipment is connected to the chamber at the hollow stud 26. The pressure equipment can include a fan and an associated control system by means of which a desired pressure can be

pre-selected and kept constant. The pressure equipment should be of the low-noise type and should be attenuated by means of silencers and insulation. Preferably, a solenoid valve is provided in the connection between the pressure equipment and the chamber, e.g. in the hollow stud 26, allowing the fan to be made inoperative and the pressure attained in the air-tightly closed chamber to be kept constant. It should of course also be possible to connect the chamber with the surrounding atmosphere via this connection or with another pressure equipment, e.g. in order to produce a varying pressure in the chamber.

FIG. 3 discloses diagrammatically such a pressure equipment. A fan 40 is connected by means of a suitable transmission to an electric drive motor 41 with a speed regulator 42. The fan has a pressure conduit 43 and a suction conduit 44. These conduits can be connected over valves 45, 46 and 47, 48, respectively, to a conduit 49 which communicates with the atmosphere, and to a conduit 50 which communicates with the interior of the pressure chamber via a valve 51. When valves 45, 47, and 51 are open and valves 46 and 48 are closed an overpressure is induced in the chamber, and when valves 46, 48, and 51 are open and valves 45 and 47 are closed an underpressure is induced in the chamber. The pressure in the chamber can be maintained by closing the valve 51 when the pressure equipment is disconnected. Preferably all valves are solenoid valves.

FIG. 3 illustrates measurement of the pressure equilibrating capacity of the Eustachian tube. An impedance meter 52V and 52H, respectively, is connected to each ear of the subject being examined, and a transducer 53 for measuring the pressure in the chamber is connected to the chamber. The impedance meters measure changes in the elastic properties of the tympanic

membrane, which indicate the pressure equilibrating capacity of the middle ear via the Eustachian tube. The signals from the impedance meters as well as the signal from the transducer 53 are supplied to two XY recorders 54V and 54H. When the pressure in the chamber is decreased the pressure equilibrating ability under simulated ascension will be obtained, and when the pressure is increased the pressure equilibrating ability at simulated diving will be obtained. These measurements can be performed with the subject in different elevations by rotation of the chamber.

In FIG. 4 there is shown in more detail how the impedance meter is constructed. Inside the chamber 14 the subject to be examined is seated, and the external ear canal of the subject's right ear is diagrammatically shown at 63, the middle ear at 64, the Eustachian tube at 65, and the nose at 66. A plug 67 having three passages 68, 69, and 70 is inserted into the ear canal, passage 68 being connected to a sound transmitter 71, passage 69 being connected to a microphone 72, and passage 70 opening into the chamber 14 via a flow resistor 73. An oscillator 74 is connected to the sound transmitter through an amplifier 75 while the microphone is connected to the XY recorder, in this case the recorder designated 54H, through an amplifier 76, a filter 77, and a rectifier 78.

The oscillator 74 can have a frequency of 220 cps, the filter 77 being a band pass filter for 220 cps and the flow resistor 73 having a resistance which can be considered as infinitely large at the frequency 220 cps.

The measurement is performed in conventional manner by supplying a measuring tone from the sound transmitter 71, a change of the air pressure in the ear canal being induced thereby. This sound pressure change

is measured by means of the microphone 72 and is dependent on the elastic properties of the tympanic membrane (impedance) the elasticity factor of which can change with different pressure gradients over the membrane (the pressure in the chamber in relation to the pressure in the middle ear).

The signal which is supplied to the XY recorder from the microphone 72 in the present case is modified in the rectifier 78 by means of a signal from the pressure transducer 53 in dependence on the pressure in the chamber 14 as well as by means of a reference signal which is supplied at 79. By means of said latter signal an adjustment is made with regard to different sound pressures in the ear canal while the signal from the pressure transducer 53 compensates for changes in the atmospheric pressure.

For hearing measurements at different pressures in the chamber the transducer 53 can be connected to an instrument indicating the pressure in the chamber. The pressure can be adjusted to predetermined values by means of the pressure equipment and then the pressure can be maintained at this value by closing the valve 51 and disconnecting the pressure equipment. Then, hearing measurements can take place at the several pressure levels without disturbing noise from the pressure equipment.

FIG. 5 shows how infrasonic influence on the sense of balance of a person can be measured by using the apparatus according to the invention. In this case a piston type pulsator 55 is connected to the chamber. This pulsator provides a sinuous pressure change and the frequency and amplitude (Δ V) thereof can be varied. The chamber should be completely dark for indicating the eye movements caused by the infrasound, such movements being a function of the amplitude and

frequency of the sound.

FIGS. 6 and 7 illustrate measurement of air resistance in the respiratory ways by using the apparatus according to the invention, FIG. 6 showing an open measurement and FIG. 7 a closed measurement. In both cases gas volume changes inside the chamber, induced by the respiration movements, are measured by means of a flow rate meter 56, the transducer 57 of which is connected through an integrator 58 to an XY recorder 59. In FIG. 6 a signal is supplied to the recorder from the transducer 60 of a flow rate meter 61 through which the subject being examined respirates, in order to indicate the inspiration and expiration flow rates in relation to the gas volume change in the chamber, while the recorder according to FIG. 7 receives a signal from a pressure meter 62 connected to the mouth of the subject for indicating the lung pressure at inspiration and expiration in relation to the gas volume change in the chamber.

As will be realized, the investigation according to FIGS. 5 to 7 as well as the investigations according to FIGS. 3 and 4 can be performed with the chamber in different rotational positions in order to determine to which extent the elevation of the subject has an influence on the values measured.

CLAIMS

1. Apparatus for examination and/or treatment of a person by methods which require indication and/or induction of pressure variations or air flow in the respiratory ways or the middle ear and/or variations of the ambient pressure, c h a r a c t e r i z e d by the combination of a pressure-tightly closable container (14), an external unit (40, 41, 42) for inducing an overpressure or underpressure in the container, a resting-surface (28, 29) for supporting the person enclosed in the container in an erect or recumbent position, a frame (10) pivotally mounting the container (14) for rotation about a substantially horizontal axis allowing the person enclosed in the container to be positioned at different elevations on the resting-surface, means for supplying pressure, flow or other signals from the container, and means for supplying pressure, flow or other signals from the respiratory ways or the middle ear of the person enclosed in the container.

2. Apparatus according to claim 1, c h a r a c - t e r i z e d in that a transducer (53) is connected to the container (14) for supplying a signal from the container, which represents the pressure in the container in relation to the ambient atmosphere.

3. Apparatus according to claim 2, c h a r a c - t e r i z e d in that a sound transmitter (71) and a sound receiver (72) are provided inside the container (14) and are adapted to be connected to the external ear canal (63) and that means (70) are provided for connecting the external ear canal to the interior of the container via a flow resistor (73).

4. Apparatus according to claim 1, c h a r a c - t e r i z e d in that an integrating air flow rate meter (56, 57, 58) is provided in a passage connecting

the interior of the container (14) with the surrounding atmosphere.

5. Apparatus according to any of claims 1 to 4, c h a r a c t e r i z e d in that a fan (32) is provided in the container (14) for circulating air within the container through cooling and/or heating means (35, 36) for maintaining a desired temperature inside the container.

6. Apparatus according to claim 5, c h a r a c - t e r i z e d in that the resting-surface comprises a seat (28) and a seat back (29) and that the fan (32) and the cooling and/or heating means (35, 36) are located in an air passage arranged below the seat and behind the seat back.

7. Apparatus according to any of claims 1 to 6, c h a r a c t e r i z e d in that the container is sound-insulated.

8. Apparatus according to any of claims 1 to 7, c h a r a c t e r i z e d in that the container is cylindrical and is rotatably mounted at one end wall (16A) thereof, preferably on a mobile chassis (10).

ABSTRACT

Apparatus for examination and/or treatment of a person.

The apparatus comprises a pressure-tightly closable container (14) with a resting-surface (28, 29) therein for supporting a person included in the container. The container is pivotally mounted for rotation about a substantially horizontal axis. An external unit (40, 41, 42) is connected to the container for inducing an overpressure or under-pressure therein. Means are provided for supplying pressure, flow or other signals from the container and from the respiratory ways of the middle ear of the person included in the container.

By rotating the container the person enclosed therein can be examined at different elevations.

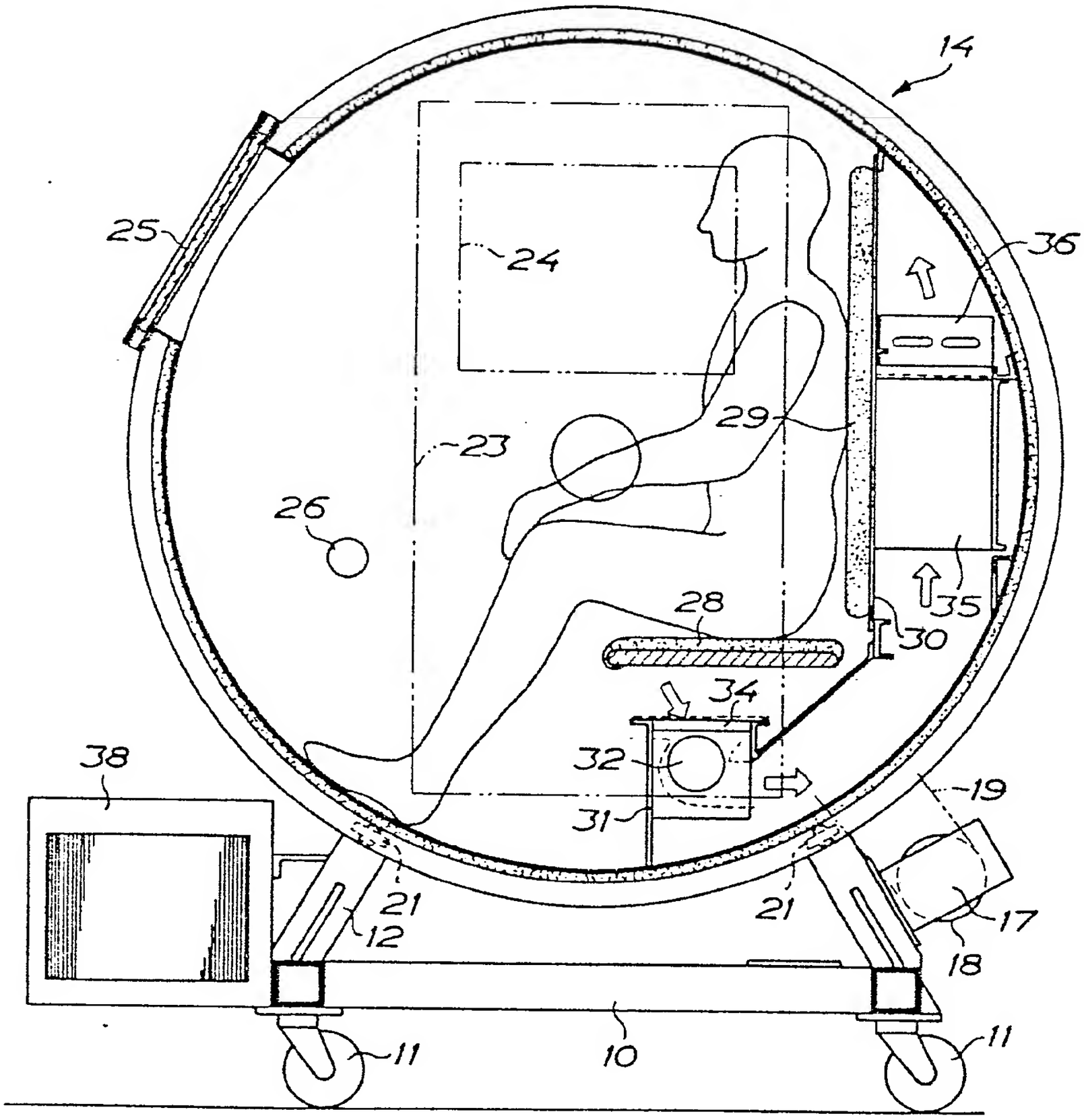
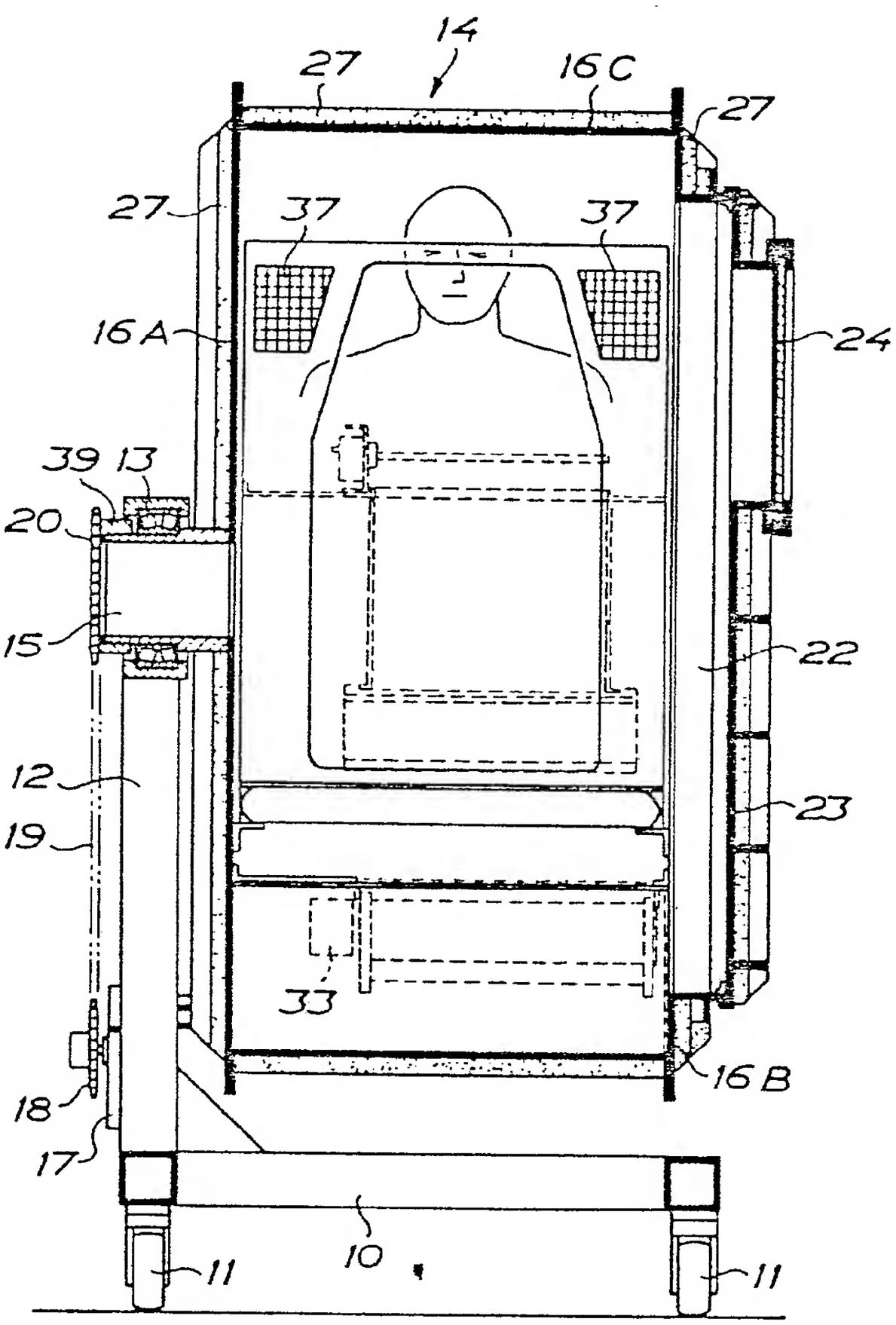


FIG. 1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16C
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27
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16A
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16B
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FIG. 2

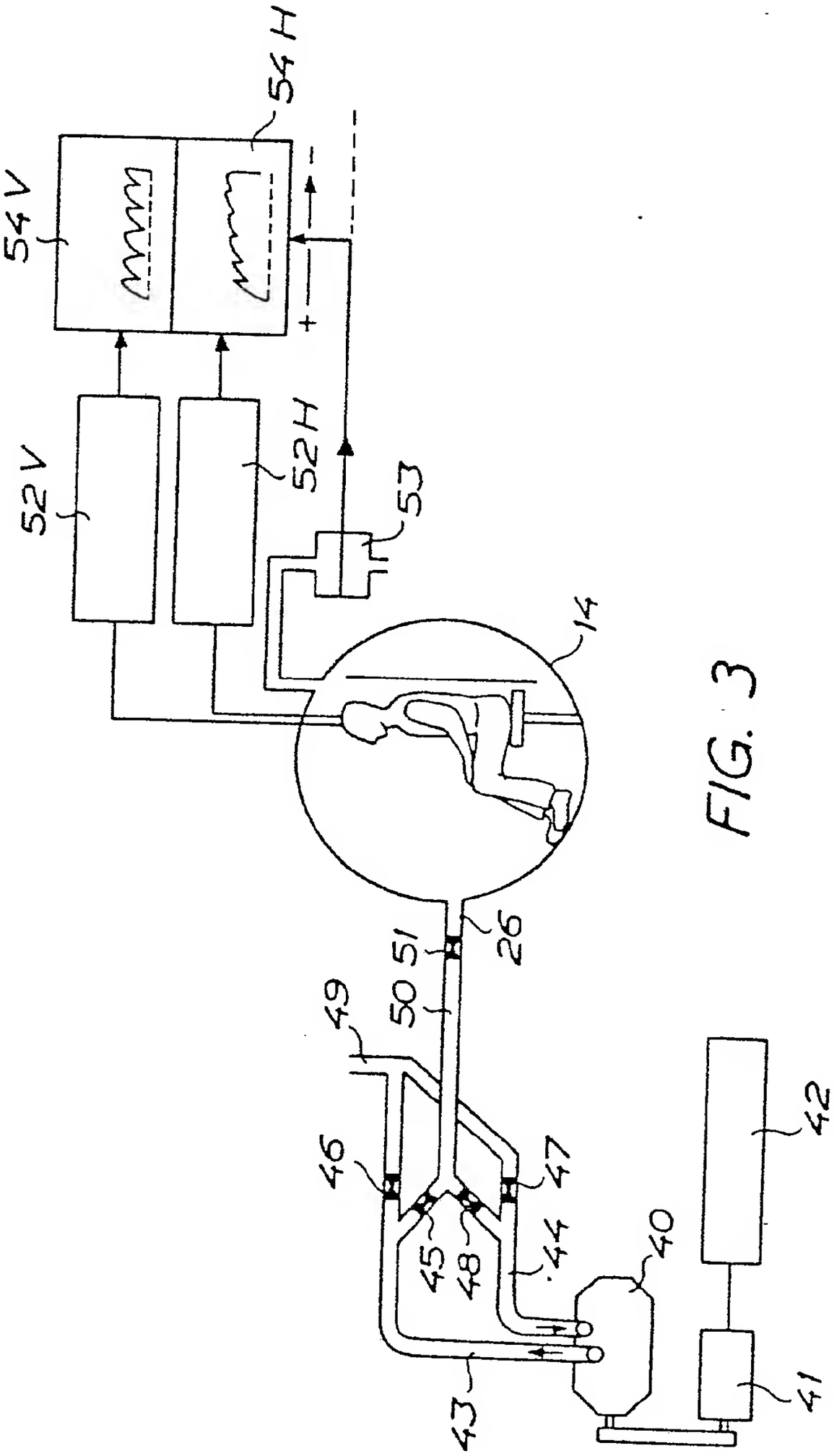
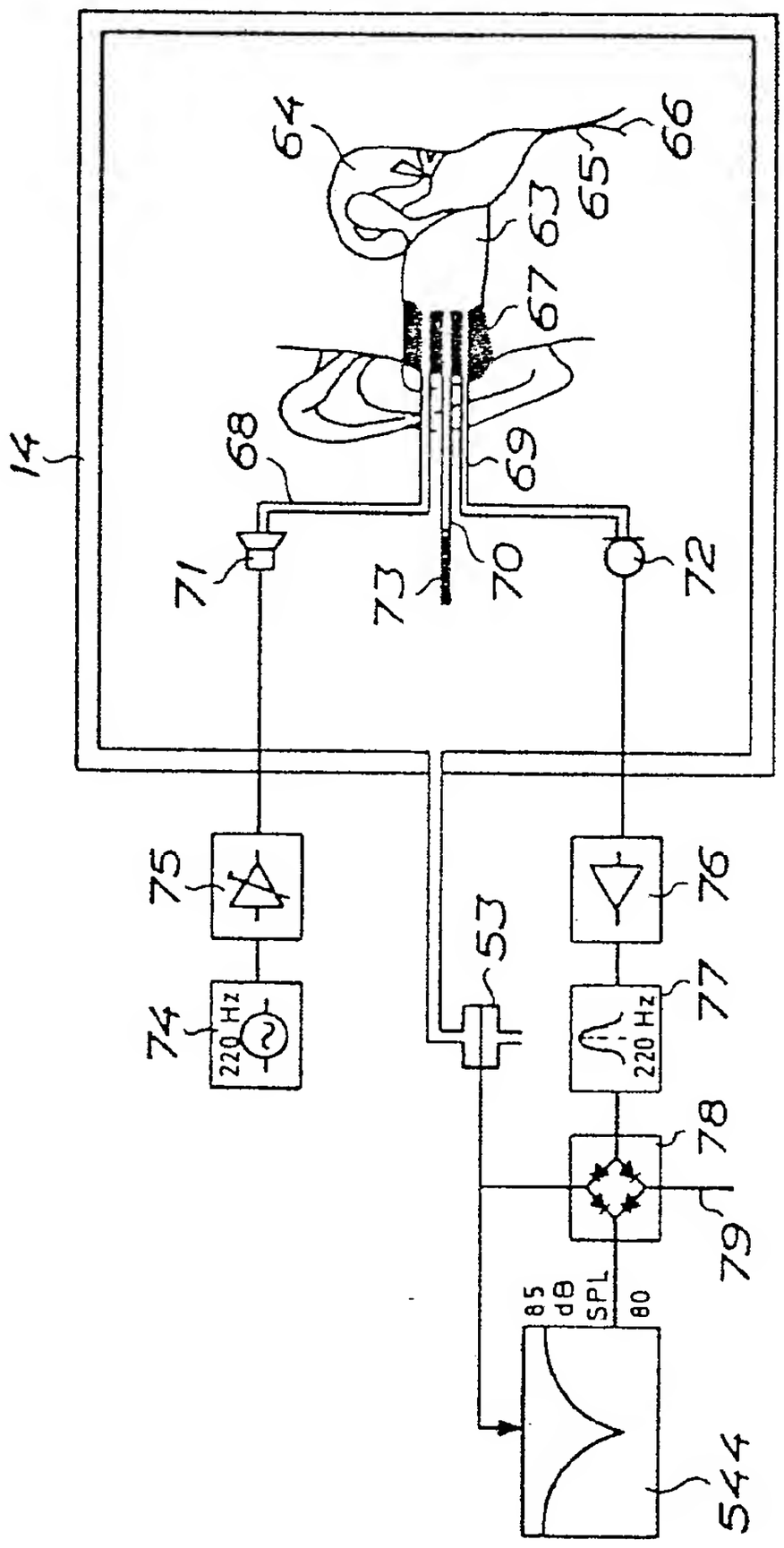


FIG. 3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63
67
68
69
14
71
73
70
72
75
74
220 Hz
53
76
77
220 Hz
78
79
85 dB SPL
80
544

FIG. 4

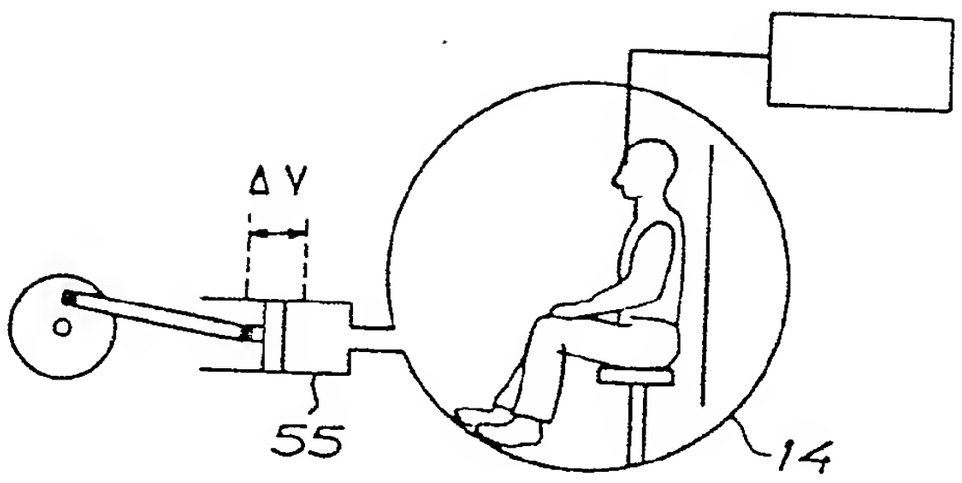

FIG. 5

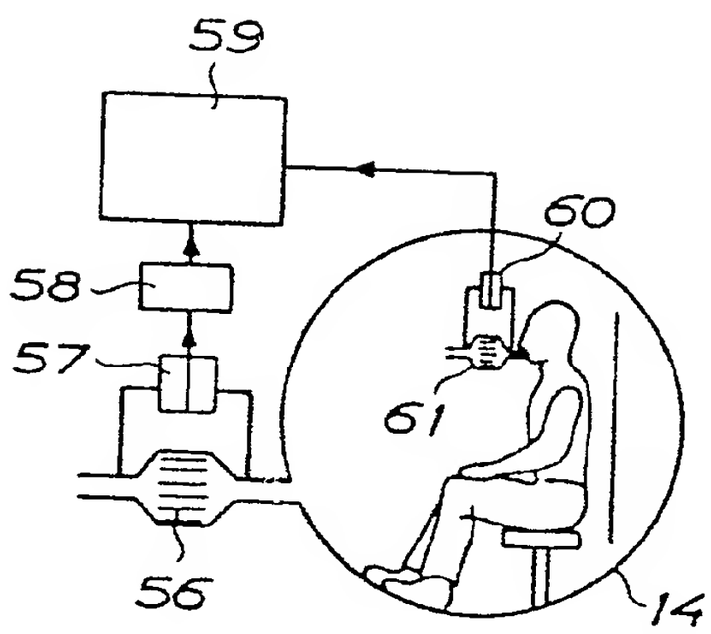

FIG. 6

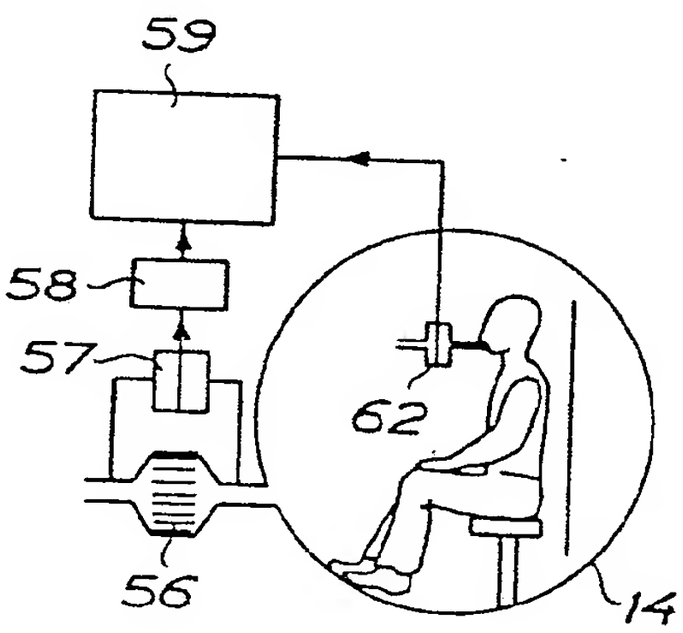

FIG. 7

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE79/00011

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

A 61 M 16/02, A 61 B 5/00

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC	A 61 B 5/00, 08, 10, A 61 M 16/02
Deutsche Kl	30a 4/05-07, 30k 13/03
US Cl	128:1, 2 C, S, 2.08

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	SE, A, 10 100/69 published 1971, January 17, P O Fahlman, O Keding	1
X	FR, A, 2 051 028 published 1971, April 2, P O Fahlman, O Keding (with priority from SE 10 100/69)	1

* Special categories of cited documents: [15]

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"T" later document published on or after the international filing date or priority data and not in conflict with the application, but cited to understand the principle or theory underlying the invention

"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search [3]	Date of Mailing of this International Search Report [3]
1979-04-20	1979-04-27
International Searching Authority [1]	**Signature of Authorized Officer [20]**
Swedish Patent Office	Lars-Erik Söderlind